Nuclear INFORMATION

Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION

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PIGS, COWS, AND FALLOUT

HOW much harm will fallout cause?

Any effort to answer that question requires that we determine the effects of very low dosages of radiation. But this is an extremely difficult matter to settle by experiment. Large doses of radiation hurt a considerable proportion of animals exposed to them, and the damage is easy to recognize. Hence it is not hard to determine what kinds of diseases are caused by large doses, and how often such diseases result from exposure. This fact means that an experimenter working with low radiation doses would have to study tremendous numbers of animals over some appreciable part of their lifetime in order to obtain useful results. Suppose, for example, that a given treatment causes a certain disease in only one animal in 1000: to pick up about ten cases of the disease, a researcher would have to treat and examine 10,000 animals! To obtain meaningful evidence on the effects of the kind of radiation we receive from fallout, an experimenter would have to work with millions of animals.

This problem is far from being of interest in the laboratory only. Since the human population exposed to fallout numbers in the many millions, even a small increase would result in a very large number of individuals being affected.

What Kinds of Facts Can We Use?

Lack of space, money, and personnel make it impractical to study millions of mice, guinea pigs, or monkeys. What, then, can the scientists do about this problem? One way to go about it is to study the effects of radiation at high intensities, and from the results attempt to predict what will happen at lower dosages. A number of such studies have already been made. The following are examples of studies of this kind: [1]

1) A certain type of a severely disabling arthritis of the spine is commonly treated by large doses of x-ray. In an extensive study of patients who had received this treatment, it was found that the incidence of leukemia was considerably greater than in the population at large. A relationship between dosage and risk of developing leukemia was noted: the higher the dosage, the greater the risk.

2) Radiation of the pelvis is sometimes carried out during pregnancy. It has been reported that infants born to mothers who have received such treatment are more likely to suffer from leukemia than other infants.

3) Children who receive treatment for enlargement of the thymus gland appear to have a higher incidence of leukemia and cancer of the thyroid gland than those who have never had such treatment.

4) A definite increase in leukemia began to appear in Hiroshima about one and a half years after the atomic bombing of that city. Evidence gathered by members of the Atomic Bomb Casualty Commission shows a convincing relation between radiation and leukemia. The peak incidence of the disease was observed in 1951 and 1952, and it has been estimated that 90% of the cases of leukemia ascribable to the bombing will have occurred within ten years. In addition, the Hiroshima evidence strongly suggests that the higher the dosage of radiation received by various segments of the population, the greater the incidence of leukemia. (See *Nuclear Information*, November, 1959.)

The Problem of Low-level Radiation

Although these studies are interesting and suggestive, none of them provide a really satisfactory answer to the question of what effects we may expect from the low-level radiation of fallout. In the studies described above, the lowest radiation used was about 70 roentgens. But the radiation from fallout is less than one hundredth of this dosage. We can't be sure that effects resulting from high dosages can be used to predict what will happen at the lower end of the scale.

Another approach would be to study the disease histories of many people in relation to the comparatively low radiation doses they receive in the course of ordinary medical diagnosis and preventive care – dental x-rays, chest x-rays, etc. It is difficult, however, to keep sufficiently detailed records that could be used to estimate the total radiation a person receives, and that would rule out the influence of the numerous other possible causes of a given disease. Studies of this kind are further complicated by the fact that everyone is exposed to a little radiation from cosmic rays and from radioactive rocks. It might be possible to set up a complex public health project that would eventually reveal the effects on human health of slight variations in radiation exposure due to locality, exposure to diagnostic x-ray, and to fallout. But this approach is not very promising – the records would become extremely complicated, and there are too many poorly understood factors that influence the appearance of a disease.

How to Get 100 Million Animals

In the face of these difficulties, one possible approach to the problem remains. Although laboratory animal experiments on a scale large enough to yield results seem impractical, there is the possibility of obtaining useful data from a study of domestic animals. In the United States nearly 100 million animals are slaughtered for food every year. Each animal is examined for disease by an inspector from the Meat Inspection Division of the Department of Agriculture. Diseased animals are rejected and do not reach the market. Detailed records have been kept for the last forty years of the occurrence of over a dozen different diseases.

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Among the diseases observed in domestic animals there is one – lymphoma – which in many respects resembles leukemia and related diseases in man. Since it is known that the incidence of leukemia in man is increased by large dosages of radiation, it is of interest to determine whether the similar disease in domestic animals reflects their exposure to low levels of radiation from natural sources and from fallout.

Lymphoma (or leukemia) was first described by German veterinarians in cattle. Unfortunately, our knowledge of the disease in cattle is much less complete than our knowledge of leukemia in man. However, sufficient information is available to indicate that the disease in cattle resembles the disease in man. Of course it would be impossible to state that cattle lymphoma and human leukemia are the same disease, or that they are due to the same factors, if only because the causes of leukemia in man are quite obscure at the present time. While high dosages of radiation may tend to encourage development of leukemia, as the Hiroshima story indicates, it seems certain that radiation is only one of many possible predisposing factors.

The problem of leukemia in domestic animals is complicated by the fact that the disease is referred to by many different names in the veterinary literature. Yet established or advanced leukemia in animals can be recognized by the inspectors by gross examination of the slaughtered animals without recourse to laboratory examinations.

Lymphoma in Cattle and Swine

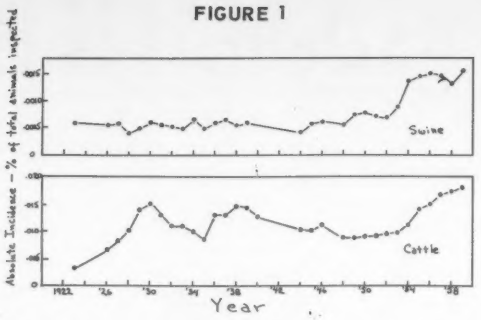
Table I shows the results contained in the most recent available reports of the Department of Agriculture. Its most striking feature is the enormous number of animals inspected every year. A controlled laboratory experiment involving so many animals would be overwhelming. The second important feature is the relatively low absolute incidence of leukemia in these animals. For purposes of crude comparison with the human disease, it is noteworthy that the death rate in man from leukemia increased from .0019% in 1920 to .0037% in 1940.

TABLE I

	SWINE			CATTLE		
Year	Total No. of Animals Inspected	No. of Cases of Lymphoma	Lymphoma Incidence %	Total No. of Animals Inspected	No. of Cases of Lymphoma	Lymphoma Incidence %
1957	62,238,000	918	.00147	20,142,000	3,418	.01700
1958	59,202,000	781	.00132	18,579,000	3,277	.01764
1959	63,870,000	1,006	.00158	17,302,000	3,151	.01821

Fluctuations in the numbers of cases of leukemia occurring yearly in cattle and swine since 1923 are shown in Figure 1. The curve for cattle show various fluctuations in incidence, and no particular trend appears evident. The curve for swine shows a more constant incidence of lymphoma in the period 1923-1944, and an irregular rise thereafter. One of the difficulties involved in interpreting these facts comes from crudeness of the inspection system, and from the varying degrees of of completeness of inspection in different years. During the war years, for example, a scarcity of governmental inspectors probably resulted in less complete inspections than at other times. In addition, it is likely that the training and experience of inspectors is not always equally good.

FIGURE 1



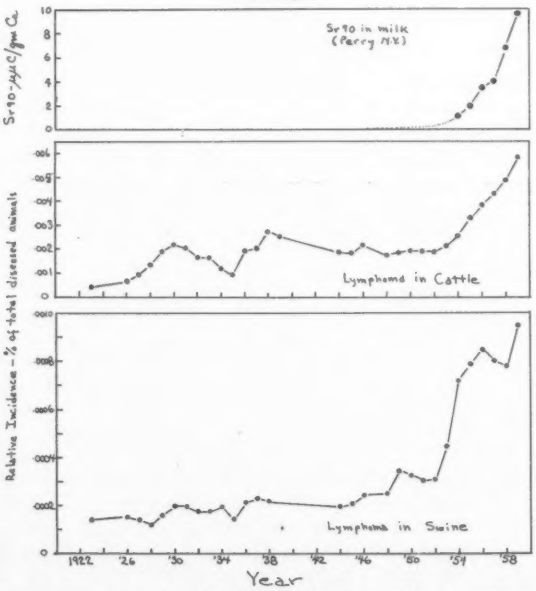
For these reasons, it seems appropriate to examine the *relative incidence* of leukemia in the animals. Relative incidence may be defined as the number of animals harboring a *particular disease* divided by the total number of animals having *any kind* of disease.

Incompleteness of inspection and other factors affecting the inspecting system may be expected to influence the recording of most, if not all, diseases. But if one disease is becoming more prevalent, it should be expected, under any conditions, to make up a larger proportion of all the cases of disease reported.

The Rise of Lymphoma Since 1953

Such an examination of the data is shown in Figure 2. In both cattle and swine, lymphoma shows an increased relative incidence between 1923 and 1930. This is probably due to the fact that it was just becoming generally recognized by veterinarians in those years. After 1930, the relative incidence of the disease in both animals remained remarkably constant until about 1953. At that time, it began to increase strikingly. In cattle, the relative incidence tripled between 1952 and 1959. In swine, the relative incidence in 1959 was four times what it had been in 1944.

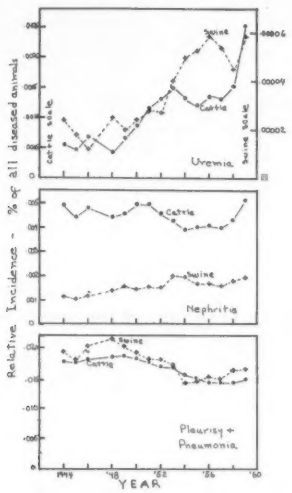
FIGURE 2



Another way to check on the possible significance of the recent increases in the incidence of lymphoma is to determine whether any other cattle and swine diseases show comparable changes. The relative incidence of

several of these – nephritis, pleurisy and pneumonia, and uremia – are shown in Figure 3, for the years 1944-59. In the case of nephritis, no significant changes have occurred, and the incidence of pleurisy and pneumonia has decreased. This situation is found for the majority of the diseases of cattle and swine, the total incidence of disease having declined steadily from 1944 to the present.

FIGURE 3



But Figure 3 shows that uremia, a disease involving the failure of the kidney, has, like lymphoma, increased since 1948, and by an amount that is quite similar to the increase in lymphoma incidence. What is known about lymphoma in cattle suggests an explanation for this relationship. Dr. A. G. Karlson's detailed study of lymphoma in cattle[2] shows that one of the features of the disease is a tendency for the lymphoma cells to invade the kidney, so that uremia may be a result of the lymphoma. It is possible that some of the animals diagnosed as suffering from uremia were actually suffering from disease of the kidney due to lymphoma.

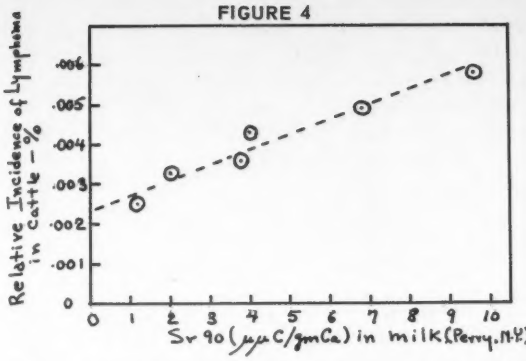
Does Fallout Cause Lymphoma?

It would appear then, that there has been a significant increase in the incidence of leukemia-like disease in cattle and swine during the period 1948-1959. Since this was the time when fallout also was increasing, the question arises as to whether there is a relation between the two.

One way to get at this question is to compare the increase in lymphoma with the increase in fallout.

Unfortunately, there are no fallout data for cattle and swine diets over the years. However, an estimate of the amount of fallout absorbed by cattle can be obtained from data on the strontium-90 content of milk. In the top curve of Figure 2, we have plotted the average Sr90 content of milk from cows in the vicinity of Perry, N.Y., where measurements have been made for a relatively long period of time.[3] Less complete data from other parts of the country show a similar trend. Figure 4 shows the relation between the Sr90 levels and the concurrent relative incidence of lymphoma in cattle. The fact that the points in this figure fall on a reasonably straight line shows that from year to year the incidence of lymphoma and the level of fallout increased by approximately the same relative amounts.

FIGURE 4



But one must exercise extreme caution in interpreting these data. The interpretation that is immediately suggested – that rising fallout caused the rising incidence in leukemia – is inadmissible without much further information. The fact that two things occur together doesn't necessarily mean that one causes the other. It is quite possible, for example, that at the same time fallout and leukemia incidence were on an increase, other factors also entered the picture, and that the rising leukemia incidence is actually related to one of these.

Some Other Possible Factors

What other factors could be involved in this rising incidence of leukemia in animals? Four possible agents appear to be particularly worthy of consideration:

1) the use of antibiotics
2) the use of hormones
3) changes in feeding practices
4) the age at which animals are slaughtered

The information that we have been able to gather shows that none of these factors changed in any decisive manner in the early 1950's. The use of antibiotic feed supplements for beef cattle is not common. Antibiotics are often fed for a few weeks to newborn pigs. The use of hormones, such as diethylstilbesterol, is common in the poultry industry but not in cattle or swine. Feeding practices have changed only gradually since the mid 1949's, but no major changes were made in the early 1950's. The time of life at which animals are killed has remained fairly constant. In some areas, there is a tendency towards earlier marketing. This change would, by itself, tend to reduce the relative incidence of leukemia rather than to increase it.

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These considerations, however, do not by any means exhaust the possibilities. It is always possible that some environmental change, unknown to us, coincided in time with the change in leukemia incidence. No matter how deeply one may look into the other possible related factors, information gained from the occurrence of leukemia in domestic animals could never carry the same degree of conviction as controlled experimentation. But since the latter has not been feasible, domestic animals do provide a hint, and suggest a good source of badly needed additional information.

If there is no further atmospheric testing of nuclear weapons, the irradiation of animals due to fallout should steadily decrease. If this decrease should be correlated with a decline of the relative incidence of leukemia in animals to the pre-1953 level, the case for radiation as the cause of the recent rise would be strengthened.

Does Geography Make a Difference?

Another way to check on the significance of the correlation between the incidence of lymphoma and fallout level would be to compare different areas of the country. In those regions which have relatively high fallout (generally, east of the Rockies), we would expect to find relatively high incidence of lymphoma; in California and the Southwest, where fallout levels are low, the incidence should be lower. Unfortunately, the available Department of Agriculture statistics do not include such regional information, but it should be possible to obtain the data from the original records. Similarly, it would be helpful to compare slaughterhouse statistics from different countries which have significantly different levels of fallout.

Most important would be information about the actual radioactivity levels of the slaughtered animals. At present there are no measurements available of the radioactivity of such animals, except for occasional measurements of some bones and cuts of meat. But at selected slaughterhouses, it would be possible, for example, to set up instruments for measuring the total radioactivity of animals. Also, key organs could be sampled for systematic determination of radioactivity levels. Correlation of such data with the concurrent statistics of lymphoma incidence would provide information of greater reliability than is now available.

How the Problem Looks Now

In sum, the evidence that is now available leads to the following conclusions:

- There has been a distinct increase in the incidence of leukemia-like disease among cattle and swine since 1948.
- The observed increase in lymphoma incidence shows a positive correlation with an increase in fallout radioactivity during this period. No other obvious factors which one might connect with the increased prevalence of lymphoma appear to be correlated in this way.
- Nevertheless, the correlation between the increased incidence of lymphoma and the fallout level cannot be considered proof that the increased prevalence of the disease is in fact due to fallout radiation.
- New kinds of observations could be made that might prove or disprove the possibility that fallout can cause increased incidence of lymphoma.

Finally, one may ask whether there is any good reason why we should go to the trouble to find the final answer to the question of animal lymphoma. There is one compelling reason. Because of the difficulties associated with studies of the effects of low-level radiation in man and in laboratory animals, it is likely that domestic animals may prove to be the *only* good source of information on this subject. Unless steps are soon taken to make the studies needed to establish whether or not fallout has caused the observed increase in lymphoma in domestic animals, it will be a long time before we will be able to find out what low levels of radiation do to the incidence of leukemia in man. E.R. and B.C.

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We wish to thank Dr. R.K. Anderson of the College of Veterinary Medicine of the University of Minnesota, for his kindness in informing us about some preliminary studies of the incidence of lymphoma in cattle which he and Dr. D.K. Sorensen carried out in 1959.

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